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None

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(54) Ink jet printhead

(57) A drop-on-demand inkjet printhead comprising an array of ink jet orifices (5 Fig 3) in a block (83) mounted at the front of an ink reservoir 3 so that when the printhead is 'pointing' horizontally or vertically downwards there is a hydrostatic head of ink producing a positive pressure at the orifices such as to cause weeping of the ink from the orifices between printing operations. The invention provides air valves A, B within the reservoir 3 arranged so that one of them always provides a port (41, 43 Fig 1) above the ink level. A pump 105 and valve arrangement 101-104 maintains a vacuum or positive pressure in the reservoir 3 such as to produce a slight negative pressure at the orifices (5). Other features of the printhead are disclosed in the spec.

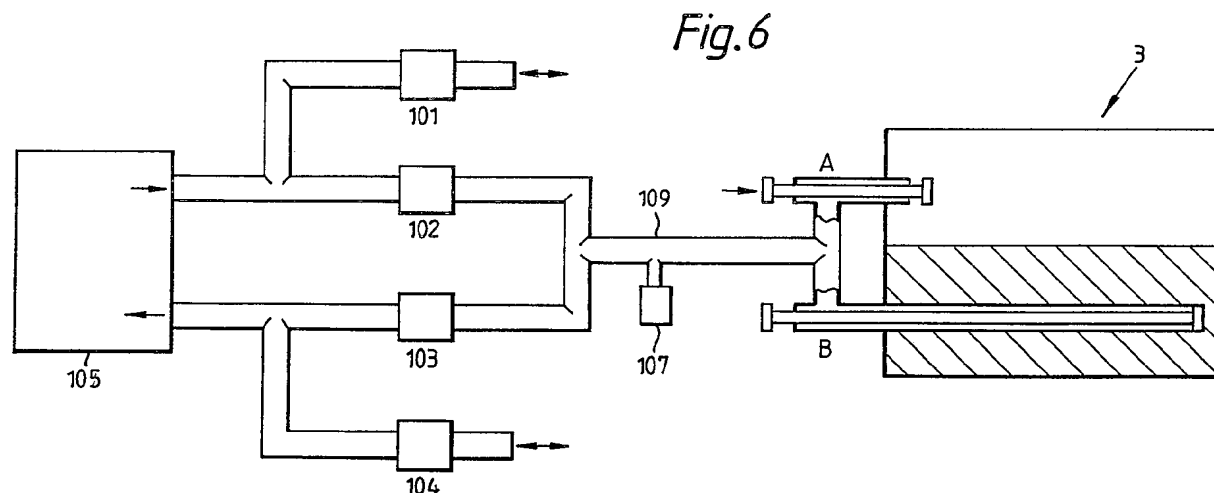
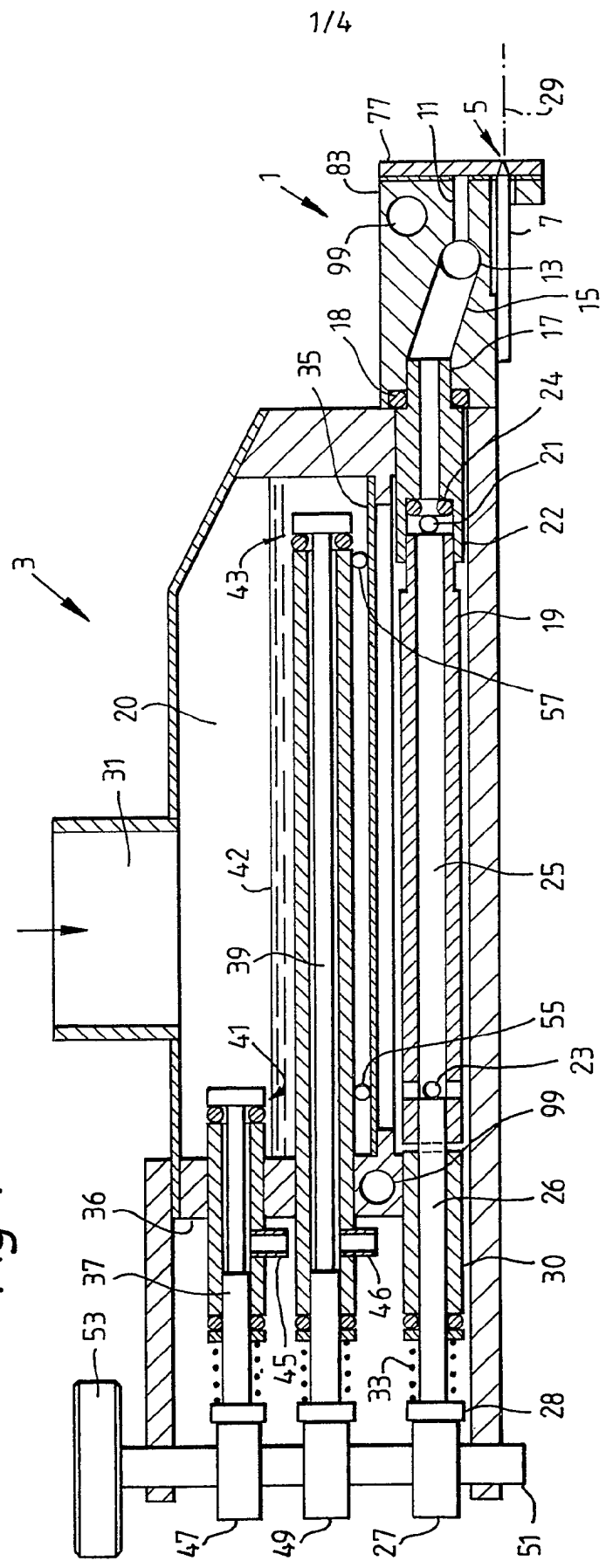


Fig 1



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Fig. 2

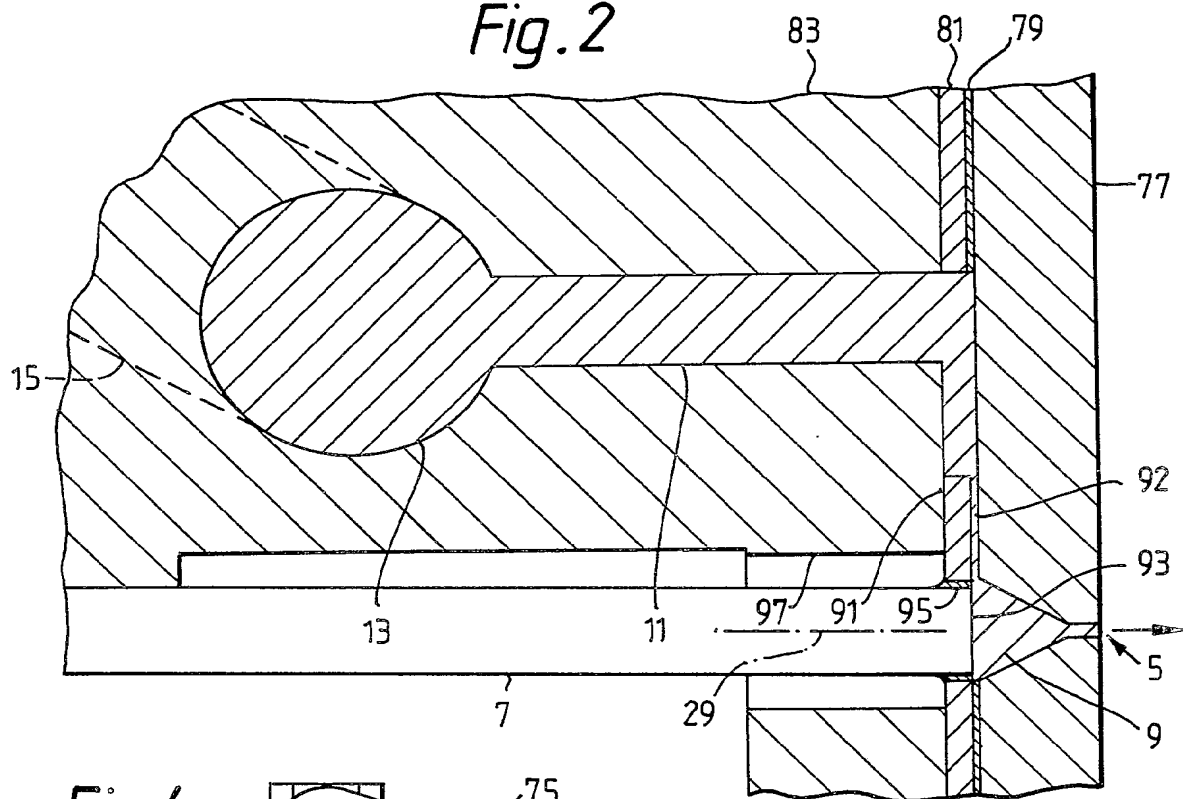


Fig. 4

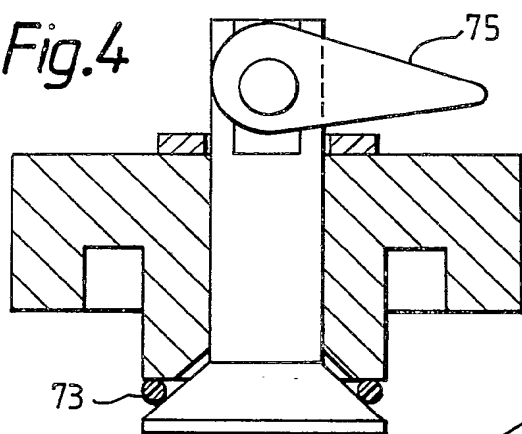


Fig. 5

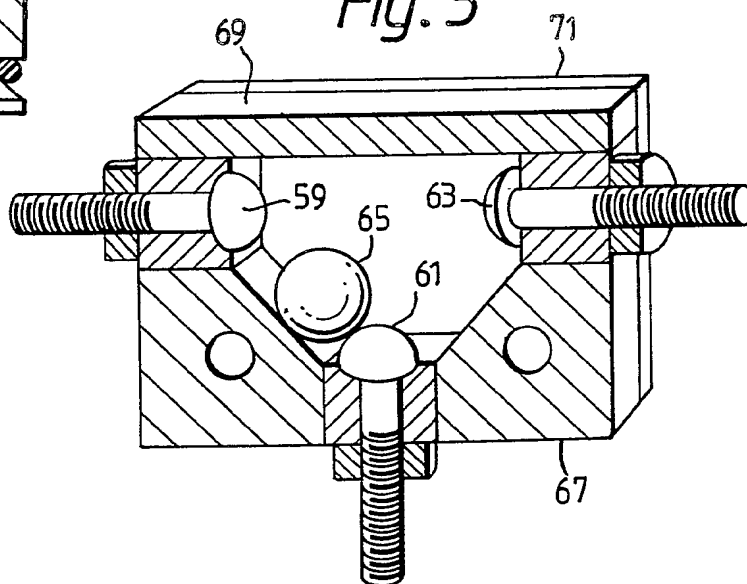
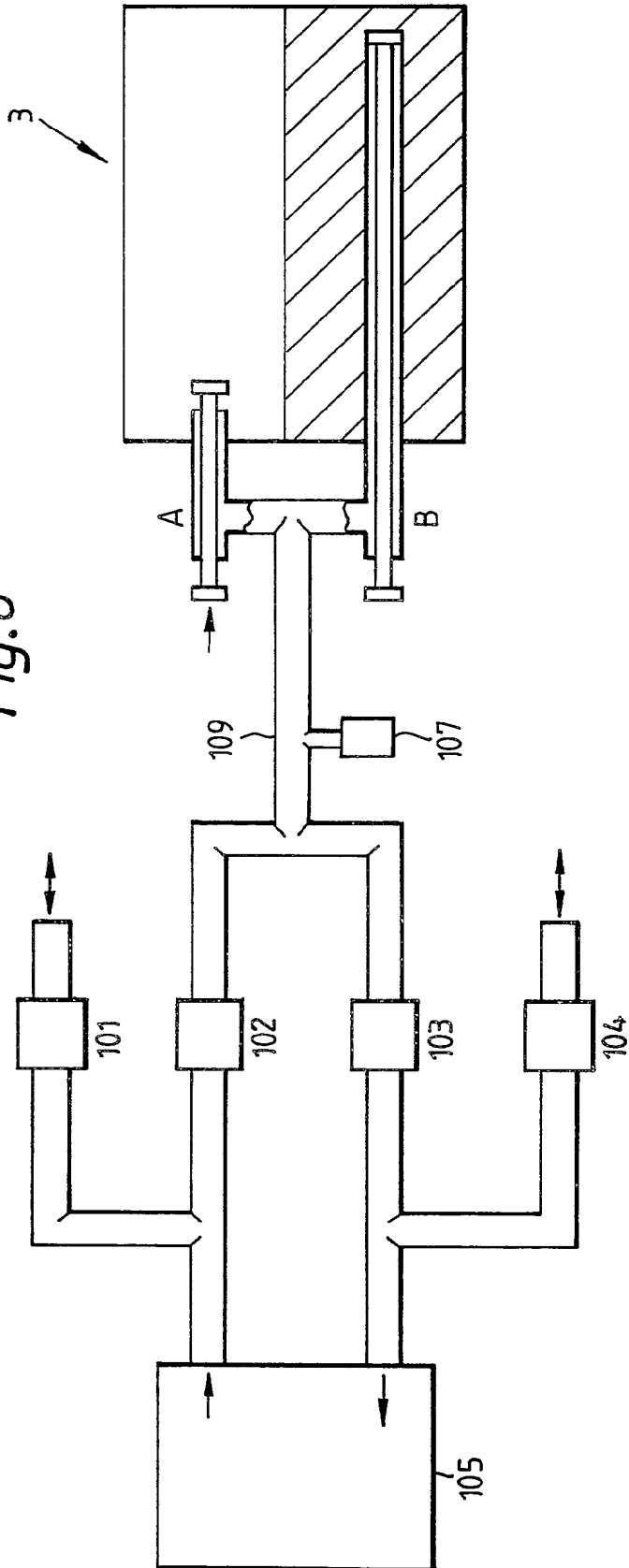


Fig.6



Ink Jet Printhead

This invention relates to a printhead for an inkjet printer. Such printers are well known in dot matrix printing systems in which one character would commonly be made up of a 5 x 7 rectangular matrix of dots. A linear array of ink jet orifices makes a broadside scan of the paper (or, more commonly, vice versa) and selected jets are activated in each (one-dot) step of the scan.

A problem arises in such printers in that the ink jet orifices weep between operations. This has been overcome in some printers by arranging that the ink reservoir is largely below the level of the orifices in operation so that there is a slight negative pressure at the orifice itself. The pulse pressure that produces the ink jet easily overcomes this negative pressure. Such an arrangement is satisfactory if the work face, the surface to be printed, is vertical so that the ink jet axis can be maintained horizontal. There is then room for the reservoir below the ink jet orifices.

It is an object of the present invention to overcome this limitation and permit an ink jet printing head to be used on a horizontal surface. In such an arrangement, of course, the reservoir is above the ink jet orifice.

According to the present information, an ink jet printhead comprises an orifice block and an ink reservoir arranged to feed the block, the block including an ink orifice and driving means coupled to

the orifice to eject a drop of ink when demanded by control means, the arrangement further comprising pressure control means coupled to the reservoir and adapted to produce, for an attitude of the printhead in which, in operation, the ink level in the reservoir is above the level of the orifice, a net negative pressure at the orifice of smaller magnitude than the ejection pressure of the driving means to prevent the orifice weeping ink between ejections of ink jet drops.

The pressure control means preferably comprises gas pumping means and a valve arrangement controllable to permit the reservoir pressure to be raised above atmospheric pressure and to be reduced below atmospheric pressure selectively. Attitude sensing means may be included for controlling the valve arrangement to produce the negative pressure at the orifice whether, in operation, the ink level in the reservoir is above or below the orifice.

The valve arrangement may provide gas ports to the reservoir at mutually remote locations so that a gas port is above the ink level for a plurality of attitudes of the printhead.

An ink feed path from the reservoir to the printhead block may comprise a tubular ink valve coupled at one end to the block and extending back, with reference to the ink ejection axis, to a position in the reservoir remote from the block, the ink valve having ink entry ports at each end to permit ink entry whether the printhead is tilted downward or upward, the ink valve being operable to open one or other of the ink entry ports selectively according to the attitude of the printhead.

The valve arrangement may comprise two tubular gas valves having gas access ports to the reservoir at mutually remote positions to permit gas venting from the reservoir irrespective of the attitude of the printhead between at least two predetermined attitudes.

With reference to a first attitude of the printhead in which the axis of ink ejection is horizontal and at the bottom of the reservoir, the tubular gas valves preferably lie one above the other, the gas access port of the upper valve being disposed at the rear of the reservoir with reference to the orifice block at the front end of the reservoir.

The two gas valves and the ink valve may be operated by respective cams on a common shaft whereby to obtain different combinations of valve condition according to the operating attitude of the printhead. The gas in question may conveniently be air.

The gas valves may have a common connection to an air pump, the common connection being to the inlet or outlet of the pump selectively. The apparatus may comprise four open/shut valves arranged to connect, respectively: the pump outlet to atmosphere; the pump outlet to said common connection; the pump inlet to said common connection; and the pump inlet to atmosphere.

An ink jet printhead in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a cross section of the printhead showing orifice block, ink reservoir, and ink and air valve arrangement;

Figure 2 is a large scale detail cross section of part of the orifice block showing one orifice and its ink feed path;

Figure 3 is an exploded diagram of the orifice block;

Figure 4 is a cross sectional diagram of the ink reservoir filter cap;

Figure 5 is a cross sectional diagram of an attitude sensor fitted to the printhead;

and Figure 6 is a diagram of the reservoir valve control arrangement.

Referring now to Figure 1, the printhead comprises an orifice block 1 mounted on the front of the printhead body 3. The block contains a linear array of perhaps 16 or 24 ink jet orifices at a pitch of the order of 1.5 millimetres. One such orifice 5 is indicated. An ink impeller or driving means 7, one for each orifice, is mounted in the block 1 with a piston face forming a rear wall of an ink chamber 9 behind the orifice 5. These details are shown more clearly in the larger scale Figure 2.

The ink feed path to the orifice 5 is by way of an individual duct 11 from a manifold 13 which is fed by a duct 15. A spigot 17 protruding from the printhead body 3 fits into an extension of the duct 15 and is sealed to the orifice block by an O-ring 18.

The spigot 17 extends from a valve body 22, which is bored to receive a sliding tube 19. The tube 19 and valve body 22 together form an ink valve C. The valve body 22 has one or more holes 21 through its wall rearward of an O-ring or other sealing washer 24 at the root of the valve body boring. Thus, when the tube 19 moves forward against the O-ring 24 it closes the hole 21 to the inside of the tube 19. When the tube 19 is retracted, the hole 21 has access to the axial bore of the valve body 22 and thus to the duct 15.

The rear end of the tube 19 is permanently fixed by brazing for example, to a solid shaft 26 the rear end of which has a cam follower 28 bearing on a cam 27. A sleeve bearing 30 fixedly mounted in the printhead body 36 carries the shaft 26 and a compression spring 33 between the sleeve bearing 30 and the cam follower 28 biases the tube 19 rearward and consequently the valve C 'open'.

Immediately forward of the shaft 26, a hole 23 in the wall of the tube 19 is permanently open and admits ink to the bore of the tube 19 except when the printhead is pointing downwards.

The attitude of the printhead as shown in Figure 1 is used as a reference for present purposes: the ink drop ejection axis 29 is horizontal, and the reservoir refill port 31 is at the top. In addition, 'forward' and 'rearward' refer to the direction of ink ejection and the opposite direction. When the printhead is turned to point vertically upwards, or in any upwardly inclined attitude, the forward port 21 is required to be closed, since it may be above the ink surface. As mentioned above, the rearward port 23 is always open.

Ink flow to the ports 21 and 23 from the reservoir 20 is through a filter layer 35 which separates off the ink valve C in the lower section of the reservoir from air valves in the upper section.

There are two air valves A and B mounted, like the ink valve C, in the wall 36 of the printhead body, and vertically in line with the valve C. The two valves are similar to the ink valve in having cam driven shafts 37 and 39 which operate ports 41 and 43 at the forward ends of the valves, to provide controllable air access to the reservoir at these port locations. Valve B extends almost to the forward end of the reservoir 20 while valve A extends only to the rear end.

The reservoir is normally less than completely full of ink so that for horizontal and for downward operation the valve A, or rather, the port 41, is above the ink surface 42, while, for upwardly inclined operation, the port 41 is immersed and the port 43 above the ink surface. Air inlet to the valves A and B is by way of ports 45 and 46 outside the reservoir.

The valve shafts 37 and 39 are driven by cams 47 and 49, the three cams being mounted on a common shaft 51 manually driven by a knob 53.

Ink level sensors 55 and 57 are mounted immediately above the filter 35, one at the rear and one at the front of the reservoir. The rear sensor 55 is used when the printhead is horizontal or pointing upwards and the forward sensor when the printhead is pointing downwards.

Mounted on the printhead body (not shown in Figure 1) is an attitude sensor shown in Figure 5. This comprises three insulated contacts 59, 61 and 63, and a gold plated metal ball 65. The body 67 of the sensor, the 'lid' 69 and the walls 71 are of metal and electronically common so that the ball can make contact between each of the contacts 59, 61 and 63 and the body according to the attitude of the device, and thus of the printhead to which it is attached. The attitude sensor is shown, diagrammatically, in section. The ball is trapped in the contact area by the side walls one of which, 71, is shown. An approximate indication of the attitude is given by the particular contact 59, 61 or 63 which is 'earthed'.

An arrangement of three mercury switches can be used instead of the ball and contact arrangement of Figure 5.

The reservoir does of course have to be sealed and a suitable filler cap is shown in Figure 4. The O-ring 73 is compressed against the ink refill port 31 by rotation of the cam lever 75 once inserted, but is freely movable in the port 31 on insertion, so avoiding pumping or pressurising of the reservoir.

Reverting now to Figure 2, this shows a cross section through part of the orifice block 1 of Figure 1, and to a much larger scale. As explained previously, the ink path is from the reservoir 20, through the duct 15 to the manifold 13 and from there through

individual ducts 11 to the orifice chamber 9. It is important that the feed path to the orifice has a restriction such that an impulse from the piezoelectric 'piston' 7 will cause ink to be ejected from the orifice 5 rather than be driven back up the feed path. To achieve this the flow losses in the feed path must not be significantly less than those for the orifice, and preferably are greater. It is difficult to provide a very small, and at the same time clearly defined, duct. This is achieved however, in the present embodiment, as illustrated in Figures 2 and 3.

The orifice block, referring to Figure 3, is made up of a number of plate-like components. The front face of the printhead consists of a plate 77 of thickness 1.25 millimetres in which is formed an array, a row, of orifices 5 and associated ink chambers 9. The ink chambers are conical, opening up to a diameter of about 1 millimetre, the orifice itself being about 0.1 millimetres diameter. The orifices in the orifice plate may be formed in various ways e.g. by a spark erosion process (EDM), punching or broaching. It may also be formed as a composite plate - a thick plate with a purely conical hole through it, and a relatively thin plate providing the final orifice in a slightly tapered cylindrical form. The pitch of the orifices is about 1.5 millimetres to accommodate the ink chamber diameter. This is clearly too great for the dot spacing in dot matrix printing and this difficulty is overcome by tilting the printhead relative to the scanning direction on the work face so that the orifices are effectively closer together. Progressive time staggering of the ink jets is then of course necessary.

Behind the orifice plate is a foil 79 having a series of longitudinal holes 85 the bottom end of which opens on to the ink chamber 9. Cutting, pressing or preferably etching a hole in the foil 79 can be done easily and accurately. The foil is conveniently of metal but this is not essential. The depth of the hole is defined entirely by the foil thickness which is readily obtainable in a wide range of values. Behind the foil 79 is a restrictor plate 81 thicker than the foil by about five times. For each orifice there is a divided hole which lines up with the hole 85 in the foil 79. This divided hole has an upper portion 87, a lower portion 89 and a

bridge 91 dividing the two portions. The upper hole portion 87 connects the foil aperture 85 to the duct 11 in the main part 83 of the orifice block. The bridge 91, coinciding with no bridge in the hole 85, limits the cross section of the ink path to the thickness of the foil 79, as shown by the neck portion 92 in Figure 2. The flow resistance presented by this restriction is determined by the thickness of the foil 79, the width of the hole 85, and the vertical extent of the bridge 91. These dimensions, and particularly the foil 79, are chosen in conjunction with the orifice dimensions to provide the correct restrictance to flow. There are two target parameters, the "refill frequency" and the "criticality of damping ratio". The design of the ink path is such as to make the former as high as is practical and the latter as close to unity as is practical. These quantities are functions of various dimensions of the ink path and various characteristics of the ink employed. Thus, in the present case, referring to Figures 2 and 3, the significant dimensions are:

- R_1 the radius of the ink chamber 9 at the rear face of the orifice plate 77;
- R_2 the radius of the orifice 5 at the front face of the orifice plate 77;
- L_1 the axial length of the ink chamber 9;
- L_2 the axial length of the cylindrical orifice 5;
- R_1 the path length of the restrictor slot 92, effectively the vertical length of the bridge 91 in the plate 81;
- R_w the width of this restrictor slot, again effectively the width of the bridge 91;
- R_t the front to back thickness of the restrictor slot 92, defined by the thickness of the restrictor foil 79;

- ρ the density of the ink;
- μ the viscosity of ink;
- τ the surface tension of the ink;

In one particular embodiment, given by way of example, the values of these quantities are as follows:

$$\begin{array}{ll}
 R_1 = 550 \text{ microns} & R_1 = 1000 \text{ microns} \\
 R_2 = 32.5 \text{ " } & R_w = 1176 \text{ " } \\
 L_1 = 1000 \text{ " } & R_t = 38 \text{ " } \\
 L_2 = 65 \text{ " } & \\
 \rho = 810 & \\
 \mu = 8000 & \\
 \tau = 0.275 \cdot 10^5 &
 \end{array}$$

Further parameters may be derived from the above as follows:

I_o the 'inertance' of the orifice and ink chamber;
 R_o the 'restrictance' of the orifice and ink chamber;
 I_r the 'inertance' of the restrictor slot;
 R_r the 'restrictance' of the restrictor slot;
 R_t the total restrictance of orifice, ink chamber and restrictor slot;
 K_m the stiffness of the ink at the orifice;
 C_d the damping factor;
 R_f the natural refill frequency;
 R_t/C_d the 'criticality of damping' ratio;

These parameters are derived from the original quantities as follows:

$$\begin{aligned}
 I_o &= \frac{\rho}{\pi} \left[\frac{L_1}{R_1 \cdot R_2} + \frac{L_2}{R_2^2} \right] \\
 R_o &= \frac{8 \cdot \mu}{\pi} \left[\left(\frac{L_1}{3(R_2 - R_1)} (R_1^{-3} - R_2^{-3}) \right) + L_2 \cdot R_2^{-4} \right] \\
 I_r &= \frac{\rho R_1}{R_w R_t} ; & R_r &= \frac{12 R_1}{R_w R_t^3}
 \end{aligned}$$

$$R_t = R_o + R_r ;$$

$$K_m = \frac{8 \tau}{\pi R_2^4}$$

$$C_d = 2[K_m (I_o + I_r)]^{0.5}$$

$$R_f = \left(\frac{K_m}{I_o + I_r} \right)^{0.5} \cdot \frac{10^6}{2 \pi}$$

By substitution of the above values it may be seen that the refill frequency is 5731 and the criticality of damping is 0.877

The orifice plate 77, foil 79 and restrictor plate 81 may be fixed to the block 83 by a series of screws around the periphery. However, this does then mean that the fixing screws put a limit on the closeness with which the ink ejection axis can approach the lower edge of the orifice block. It is desirable that this distance is reduced as far as is practicable to permit printing close to the edge of the work face. The preferred arrangement that has been devised is one in which the three components 77, 79 and 89 are welded to the block 83 around their edges by an electron beam (EBP) process. The ink jet axis 29 can then be positioned very close to the edge, eg within three millimetres of the edge.

The transducer 7 is fixed at its rear end to the orifice block 1 so that the front face 93 is free to move axially under the effect of an electric field. When this field is applied (by conventional means not shown), the transducer contracts along the axis 29 and sucks ink through the restriction or neck 92 into the chamber 9. Removal of the electric field allows the transducer to expand suddenly and cause the ejection of a drop of ink from the orifice 5.

While the transducer 7 may be a circular cylinder of piezoelectric material, it is conveniently of rectangular cross section thus facilitating the provision of electrode layers on opposite surfaces. Where the (front) end face 93 of the transducer is square, its corners may overlap the circular opening of the ink chamber 9. The front face 93 is rearwards of the ink chamber opening and the movement of the front face is far too small to cause any fouling.

An improvement on the basic design of the transducer consists in the relieving of its upper and lower surfaces from a point behind the front face 93 so that the vertical longitudinal cross section consists of a T or hammer shape. The vertical thickness of the major part of the length, ie the shaft, of the transducer is thereby reduced, the electrodes on the upper and lower surfaces are closer together, and the voltage sensitivity is increased. In general the shaft dimension between the electrodes is smaller than any transverse dimension of the end face. The volumetric displacement of the piston face 93 is thereby maximised for minimum applied voltage. A suitable thickness reduction is approximately half of the square dimension of the face 93.

Consistent and reliable operation of the transducers is assisted by poling of the piezoelectric material after assembly. This process involves applying a d.c. voltage in excess of that used in operation at an elevated temperature. The polarity of the transducer relative to the piezoelectric force developed is thus determined. All of the transducers are fixed to the orifice block before the poling process so that the fixing process does not disturb the imposed piezoelectric characteristic, as it tends to if done in the reverse order.

In addition to fixing the transducers before the poling process, the electrode flying leads are soldered to the electrodes before poling. The poling temperature is significantly lower than the soldering temperature so that, while soldering can certainly damage pre-poled elements, poling can not harm the soldered connections.

Once the leads are soldered to the electrodes the transducers are then clamped at their rear portions to the orifice block and the poling process performed.

The transducer 7 must be sealed against leakage of ink around the edge of its front face 93, and this is achieved by an elastomeric sealant 95 around the transducer on the rear face of the restrictor plate 81. This resilient seal will allow sufficient axial movement of the transducer 7.

Other designs of transducer may be employed: piezoelectric multilayers may be employed in which a number of layers of piezoelectric material are driven in parallel, so reducing the necessary driving voltage. Single and multilayer devices employing

magnetostrictive or electrostrictive ceramic material, provide further alternatives. Again, while the device described above uses the longitudinal mode of the piezoelectric material, the thickness and shear modes may be used alternatively.

Heaters 99 are positioned in the orifice block and in the rear wall of the reservoir for use when hot melt ink is being used.

Referring now to Figure 6, this shows printing apparatus including, diagrammatically, the reservoir 3 of Figure 1 including air valves A and B, on/off solenoid valves 101, 102, 103 and 104, an air pump 105 and a pressure sensor 107. The air valves A and B have a common connection 109 to the solenoid valve arrangement. The latter is such that valve 101 opens to connect the pump outlet to atmosphere; valve 102 opens to connect the pump outlet to the common connection 109; valve 103 opens to connect the pump inlet to the common connection; and valve 104 opens to connect the pump inlet to atmosphere.

Suitable operation of the valves 101-104 permits the reservoir pressure to be reduced below atmosphere pressure, raised above atmosphere pressure, or maintained at atmospheric pressure. For example, if valves A, 101 and 103 are open and valves B, 102 and 104 closed, operation of the pump will evacuate the reservoir.

The pressure sensor gives a measure of the reservoir pressure and a feedback system (not shown) can be used to maintain the pressure at a pre-set value.

The valves 101-104 are operated in dependence upon the attitude of the printhead as indicated by the attitude sensor shown in Figure 5 (or other device fixed to the printhead).

In order to put the printhead into operation the following procedure is undertaken. After closing both air valves A and B by turning the knob 53 which activates the cams 47, 49, 27, the printhead is placed in a horizontal position. The filler cap is removed and the reservoir filled with ink. This ink may be poured as a granular form in the case of hot-melt ink or as a liquid in the case of ordinary ink. Hot-melt ink could be melted first and then poured into the reservoir. A level sensor may be used to detect when the reservoir is full. Alternatively, the level could be viewed through a sight-glass set into the side of the reservoir.

When the reservoir is full and the printhead turned to its required attitude the appropriate air valve A or B may be opened and the pressure in the reservoir void adjusted until the hydrostatic head of ink is balanced. The removal or addition of air can be accomplished by a bellows, pump or piston. The preferred design, shown in Figure 6, uses a diaphragm pump with two valves connected to the inlet and two to the outlet.

Although air has been specified as the working medium for pressure regulation any compatible gas may be used. Helium would have the desirable property of depressing the solubility of dissolved gases.

It may be that in changing the attitude of the printhead from printing on a horizontal surface to printing on a vertical surface, pressure in the reservoir is too negative say. In this case the pump/valves may be set to pump air into the reservoir or both valves of one pair could be opened to allow air to flow into the reservoir. Similarly if the pressure is too positive the pump/valves could be set to evacuate or the valves of one pair opened as before to let air out of the reservoir.

In practice the attitude sensor (Figure 5) detects which attitude the printhead has been set to print in, an electronic circuit (not shown) transforms the signals from the attitude sensors into an appropriate sequence for the valves 101-104. The sensor 107 measures the pressure in the reservoir and a control system switches on the pump until the desired pressure is reached.

As ink is used the level of ink in the reservoir alters, changing the hydrostatic head of ink acting on the orifices. Therefore, for optimum performance of the printhead, the partial pressure applied to the reservoir needs to be changed as ink is used. One method of determining how much ink has been used, from an initially full state, is to count the number of drops that have been jetted from the printhead and from a knowledge of drop volume the total volume can be calculated. The counting may be done in a microprocessor that commands the head to print or electronically by processing the electrical signals to the piezoelectric transducers. The ink level can always be detected with a level sensor or sensors in the reservoir.

It may be necessary as a prerequisite to operation of the printhead to purge it of air in the ink channels. This may be accomplished by switching the valves 101-104 to the positive pressure mode and pressurising the reservoir at an above atmospheric pressure. This will cause ink to jet out of all of the orifices 5 carrying any entrapped air with the ink. This process may be aided by pulsing the piezoelectric transducers 7 with a pulse train of electrical signals to provide ultrasonic agitation of the ink within the ink chambers.

CLAIMS

1. An ink jet printhead comprising an orifice block and an ink reservoir arranged to feed the block, the block including an ink orifice and driving means coupled to the orifice to eject a drop of ink when demanded by control means, the arrangement further comprising pressure control means coupled to the reservoir and adapted to produce, for an attitude of the printhead in which, in operation, the ink level in the reservoir is above the level of the orifice, a net negative pressure at the orifice of smaller magnitude than the ejection pressure of said driving means to prevent the orifice weeping ink between ejections of ink jet drops.

2. A printhead according to Claim 1, wherein said pressure control means comprises gas pumping means and a valve arrangement controllable to permit the reservoir pressure to be raised above atmospheric pressure and to be reduced below atmospheric pressure selectively.

3. A printhead according to Claim 2, including attitude sensing means for controlling said valve arrangement to produce said negative pressure at said orifice whether, in operation, the ink level in the reservoir is above or below the orifice.

4. A printhead according to Claim 3, wherein said valve arrangement provides gas ports to the reservoir at mutually remote locations so that a gas port is above the ink level for a plurality of attitudes of the printhead.

5. A printhead according to Claim 4, wherein an ink feed path from the reservoir to said printhead block comprises a tubular ink valve coupled at one end to the block and extending back, with reference to the ink ejection axis, to a position in the reservoir remote from the block, the ink valve having ink entry ports at each end to permit ink entry whether the printhead is tilted downward or

upward, the ink valve being operable to open the forward ink entry port according to the attitude of the printhead.

6. A printhead according to any preceding claim, and including ink-level sensors located at mutually remote positions in the reservoir to detect a low level of ink irrespective of the attitude of the printhead between at least two predetermined attitudes.

7. A printhead according to any preceding claim, wherein said valve arrangement comprises two tubular gas valves having gas access ports to the reservoir at mutually remote positions to permit gas venting from the reservoir irrespective of the attitude of the printhead between at least two predetermined attitudes.

8. A printhead according to Claim 7, wherein, with reference to a first attitude of the printhead in which the axis of ink ejection is horizontal and at the bottom of the reservoir, the tubular gas valves lie one above the other, the gas access port of the upper valve being disposed at the rear of the reservoir with reference to the orifice block at the front end of the reservoir.

9. A printhead according to Claim 7 or Claim 8 as appendent to Claim 5 wherein said two gas valves and said ink valve are operated by respective cams on a common shaft whereby to obtain different combinations of valve condition according to the operating attitude of the printhead.

10. A printhead according to any preceding claim, wherein said pressure control means is arranged to control air pressure in the reservoir

11. A printhead according to any preceding claim wherein said driving means comprises a piezoelectric transducer having a driving face constituting one wall of an ink chamber behind the respective orifice.

12. Printing apparatus including printhead according to any of Claims 7, 8 and 9, wherein said gas valves have a common connection to an air pump, the common connection being to the inlet or outlet of the pump selectively.

13. Printing apparatus according to Claim 12, comprising four open/shut valves arranged to connect, respectively: the pump outlet to atmosphere; the pump outlet to said common connection; the pump inlet to said common connection; and the pump inlet to atmosphere.

14. A printhead substantially as hereinbefore described with reference to Figures 1, 4, 5 and 6 of the accompanying drawings.

Patents Act 1977**Examiner's report to the Comptroller under
Section 17 (The Search Report)**

Application number

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Relevant Technical fields

(i) UK CI (Edition K) B6F - FLM, FLQ, FLR, FLT

(ii) Int CI (Edition 5) B41J 2108, 1045, 2117, 1175
G01D 15/18

Search Examiner

R D CAVILL

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

25 AUGUST 1992

Documents considered relevant following a search in respect of claims 1 TO 14

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

Category	Identity of document and relevant passages	Relevant to claim(s)

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